Inferring Acceptance and Rejection in Dialogue
by Default Rules of Inference

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Abstract

This paper discusses the processes by which conversants in a dialogue can infer whether their assertions and proposals have been accepted or rejected by their conversational partners. It expands on previous work by showing that logical consistency is a necessary indicator of acceptance, but that it is not sufficient, and that logical inconsistency is sufficient as an indicator of rejection, but it is not necessary. I show how conversants can use information structure and prosody as well as logical reasoning in distinguishing between acceptances and logically consistent rejections, and relate this work to previous work on implicature and default reasoning by introducing three new classes of rejection: IMPLICATURE REJECTIONS, EPISTEMIC REJECTIONS and DELIBERATION REJECTIONS. I show how these rejections are inferred as a result of default inferences, which, by other analyses, would have been blocked by the context. In order to account for these facts, I propose a model of the common ground that allows these default inferences to go through, and show how the model, originally proposed to account for the various forms of acceptance, can also model all types of rejection.

1 Introduction

A common view of dialogue is that the conversational record is part of the COMMON GROUND of the conversants. As conversants A and B participate in a dialogue, A and B communicate with discourse acts such as PROPOSALS, ASSERTIONS, ACCEPTANCES and REJECTIONS. If A proposes an act α and B accepts A's proposal then the act α becomes a mutual intention in A and B's common ground. If A asserts a proposition ϕ and B accepts A's assertion, the ϕ becomes a mutual belief in the common ground. If B rejects A's assertion or proposal, then what is rejected is not added to the common ground [Stalnaker, 1978]. Whenever conversants A and B must remain coordinated on what is in the common ground [Thomason, 1990], they must monitor whether their utterances are accepted or rejected by their conversational partners.

Coordinating on what is in the common ground would be straightforward if conversants always explicitly indicated acceptance or rejection with forms such as *I agree* or *I reject your proposal*. However there are a variety of ways to indicate both acceptance and rejection in natural dialogue, most of which rely on making inferences from form to function.

For example, previous work suggests that B can indicate acceptance by simply going on to the next topic, with phrases such as *uh huh, okay, sure, alright*, or with full or partial repetitions. For example, consider the partial repetition in 1, by which B accepts A's assertion.

(1) A: Sue's house is on Chestnut St.

   B: on Chestnut St.

B can also indicate acceptance with paraphrases of what A said, and with utterances in which B makes an inference explicit that follows from what A has just asserted or proposed [Carberry, 1989, Clark and Schaefer, 1989, Whittaker and Stenton, 1988, Walker, 1992].

It has been suggested that what unifies the forms of acceptance is logical consistency with the context: explicit indicators of acceptance provide 'no new information' [Whittaker and Stenton, 1988]. Thus it would appear that if A can identify the beginning of a new topic and detect whether B's response is logically consistent with what A has said, then A can infer whether B has accepted A's assertion or proposal.

The correlation between form and function for indicators of rejection also appears to require A to make logical inferences. Horn's review of the literature suggests that the types of rejection include: (a) DENIAL as in 2; (b) LOGICAL CONTRADICTION as in 3; (c) IMPLICIT DENIAL as in 4, where B denies a presupposition of A's; and (d) REFUSAL, also called REJECTION where B refuses an offer or proposal of A's [Horn, 1989].

(2) A: Pigs can fly.

   B: No, you idiot, pigs can't fly! (Horn's 29)

(3) A: Kim and Lee have been partners since 1989.

   B: But Lee said they met in 1990.

(4) A: Julia's daughter is a genius.

   B: Julia doesn't have any children.

(5) A: Come and play ball with me.

   B: No, I don't want to. (Horn's 33)

The assumption seems to have been that A can identify these forms as rejections by recognizing logical inconsistency either directly from what was said, or via an inferential chain [Gazdar, 1979, Allwood, 1992] *inter alia*. Thus much of previous work would lead one to believe that there is a neat trichotomy with the processing that A must do to monitor additions to the common ground:

1. A detects logical consistency: leads A to an inference of EXPLICIT ACCEPTANCE

2. A detects the initiation of a new topic: leads A to an inference of IMPLICIT ACCEPTANCE

3. A detects logical inconsistency: leads A to an inference of REJECTION

Unfortunately things are not so simple. Consider the rejection in 6B:

(6) A: There's a man in the garage.

B: There's something in the garage.

The proposition realized by 6B follows from 6A as an entailment via existential generalization. Thus 6B REJECTS 6A while being logically consistent with it.[1] The only possible conclusion is that rejections need not be logically inconsistent. But if a logically consistent utterance such as 6B can function as a rejection, how does A identify 6B as a rejection? And how does A distinguish between logically consistent utterances that indicate acceptance such as 1B and utterances that indicate rejection such as 6B? I argue that the inference of rejection arises as a QUANTITY IMPLICATURE from the fact that B's utterance was less informative than it might have been [Hirschberg, 1985], leading to the implicature in 7:

(7) It's not a man.

However, this analysis raise several additional issues. First, it is well known that implicatures are default inferences that are cancellable by prior context. Since the implicature in 7 is not consistent with the assertion in 6A, how does the implicature arise? Furthermore, if 6B can implicate 7 by only confirming a part of what was asserted, why doesn't 1B potentially implicate 8?

(8) It's not Sue's house.

The goal of this paper is to specify in more detail the processes by which conversants infer whether their assertions and proposals have been rejected by their conversational partners, and to specify what features of the utterance they use in doing so.

The discussion above suggests that logical consistency is necessary for an indicator of explicit acceptance, but it is not sufficient. On the other hand, logical inconsistency is sufficient as an indicator of rejection, but it is not necessary.

Throughout the paper, I will ignore the existence of explicit forms for indicating acceptance or rejection such as *Yes, I agree* or *No, I don't want to*, on the basis that their analysis is straightforward. In particular, nothing I have to say about the linguistic cues for distinguishing acceptance from rejection apply to utterances which explicitly assert acceptance or rejection.

In order to provide an empirical basis for this study, I collected 43 examples of acceptance and 31 examples of rejection from a corpus of financial advice dialogues and from the literature. [2] Section 2 discusses the forms for indicating acceptance and the cues that conversants might use to infer acceptance. Section 3 discusses the inference of rejection. I use the corpus analysis to show that there are many more types of rejection than previously noted, and that conversants use information structure as well as logical reasoning in inferring rejection. In section 4, I discuss features of utterances that are useful in distinguishing acceptance from rejection, namely information structure and prosodic realization. In section 5, I show that modeling the function of these utterances requires a model of the common ground in which beliefs can be only weakly mutual, and in which beliefs inferred by default rules of inference are represented differently than beliefs inferred as entailments.

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[1]The model of the common ground in section 5 represents the fact that B's utterance is a partial acceptance as well as a rejection, since it accepts a proposition entailed by A's assertion, namely what B asserts in 6B.

[2]Most of the examples are from a corpus of radio-talk show dialogues about financial advice, which consists of 55 dialogues from 5 hours of live broadcast. This corpus was first taped and transcribed by Julia Hirschberg and Martha Pollack, and reported on in [Pollack *et al.*, 1982]. There are many more examples of acceptance in the corpus than are discussed here, but only 31 examples of rejection were identified in the 55 dialogues. I am grateful to Julia Hirschberg for providing me with audio tapes of the original broadcast, and to Mark Liberman for prosodic analysis tools.

2 Inferring Acceptance in Dialogue

As mentioned above, there is a large amount of variation in the forms by which acceptance is indicated [Clark and Schaefer, 1989, Whittaker and Stenton, 1988, Walker and Whittaker, 1990]. This section first briefly discusses some features of the dialogue model that underlie the analysis of acceptance presented below, and then discusses the various forms of acceptance found in 43 examples from the financial advice dialogue corpus [Pollack *et al.*, 1982] and in the literature. The main focus of this discussion is the way in which the realization of these forms allows conversants to distinguish acceptance from rejection, and thus stay coordinated on what is added to the common ground during a conversation. I focus on forms which do not explicitly assert acceptance since treatment of these should be straightforward.

A primary open issue about the various forms that indicate acceptance, is whether any forms that don't explicitly assert *I believe you* or *I agree* indicate anything more than simply understanding. For example, a point of controversy is whether a phrase such as *uh huh* can be used to indicate the adoption of belief or the commitment to a proposed course of action [Schegloff, 1982, Grosz and Sidner, 1986]. I will argue that utterances that add no new information, which occur as B's response, assert understanding with various strengths, but only implicate acceptance.[3]

A secondary issue is that previous work has proposed that there is a class of IMPLICIT ACCEPTANCES. The claim is that speaker A is licensed in inferring acceptance if speaker B produces an utterance about a new topic in response to A's assertion or proposal [Clark and Schaefer, 1989], or if B's response "cannot be interpreted as initiating a negotiation dialogue" [Lambert and Carberry, 1991]. I will assume that under certain circumstances, acceptance can be indicated implicitly, and will argue that the inferences involved in inferring acceptance under these circumstances are the same as those involved in making the inference from an assertion of understanding to acceptance, as discussed above for explicit forms of acceptance.

Finally, I claim that both the 'no new information' forms, and the cases of IMPLICIT ACCEPTANCE only implicate acceptance under certain circumstances.

The first condition for implicating acceptance is that there is a conventional assumption shared between the conversants of what I call the ATTITUDE LOCUS. The ATTITUDE LOCUS is the sequential position in conversation, just after A's assertion or proposal, in which B first has an opportunity to express B's attitude or evaluation of A's utterance. I will show below that there is good evidence for the existence of the ATTITUDE LOCUS.

The second condition, is that given the ATTITUDE LOCUS, conversants in particular types of conversations, such as task-oriented or problem-solving dialogues, appear to observe the rule of collaborative interaction in 9:

(9) COLLABORATIVE PRINCIPLE: Conversants must provide evidence of a detected discrepancy in belief as soon as possible.

The COLLABORATIVE PRINCIPLE is an abstraction of the collaborative planning principles proposed by [Whittaker and Stenton, 1988, Walker and Whittaker, 1990]. The effect of this principle is that conversants can make default inferences of acceptance from the fact that B has provided no evidence of rejection or evidence that there is a need for clarification in the attitude locus.

Thus, only the existence of the attitude locus and the assumption that conversants are following the collaborative principle can license the implicature of acceptance from forms that only indicate

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[3]Forms that add no new information include prompts such as *uh huh*, repetitions, paraphrases, and utterances that make inferences explicit.

4

understanding, or from the implicit acceptance situations that Clark and Carberry discuss. Below I will refer to forms that only assert understanding, but implicate acceptance, as forms of explicit acceptance.

Section 2.1 discusses forms of explicit acceptance that provide no new information. In each example, the explicit acceptance form is indicated in **boldface**, while the assertion or proposal that it accepts is indicated in *italics*. In section 5, I will show how the inference from these forms to the implicature of acceptance is reflected by a model of the common ground in which the implicated acceptances are defeasible.

2.1 Forms of Explicit Acceptance

Dialogue 10 is a financial advice dialogue about a way to reinvest the caller's pension. It illustrates the most minimal forms for explicit acceptance, prompts such as *uh huh*, *I see*, *Sure*, *Right*, and *okay* as in 10-34 and 37 [Schegloff, 1982].[4]

(10) (33) H: Well, the amount that you have, the excess amount, the twenty eight hundred
     (34)R: Okay
     (35)R: the amount that was not your own contribution, you rollover.
     (36) R: You rollover.
     (37) H: Right....

Dialogue 11 is an excerpt from a financial advice dialogue about how to reinvest the caller's certificates of deposit as they come due. Partial repetitions such as 11-27 are commonly used to indicate acceptance. See also the partial repetition in 10-36.

(11) (26) H: That's right. as they come due, give me a call, about a week in advance. But the first one that's due the 25th, *let's put that into a 2 and a half year certificate*
     (27) E: **Put that in a 2 and a half year**. Would ...
     (28) H: Sure. We should get over 15 percent on that

An example of the use of paraphrase to indicate acceptance is found in 12-20:

(12)   (18) H: I see. *Are there any other children beside your wife?*
        (19) D: *No*
        (20) H: **Your wife is an only child**.
        (21) D: Right. And uh he wants to give her some security ....

The final type of 'no new information' forms for indicating acceptance are utterances that make inferences explicit that follow from what has just been asserted or proposed [Walker, 1992].[5] Consider dialogue 13, where H makes an inference explicit in 13-(17). This inference follows from the context that the tax year under discussion is 1981, from the inference rule of MODUS TOLLENS, and from the context that results from adding 13-15 and 13-16 to the original context.

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[4]These kinds of phrases have also been called ACKNOWLEDGMENTS and BACKCHANNELS [Whittaker and Stenton, 1988, Walker and Whittaker, 1990, Traum, 1994, Carletta, 1992].

[5]Both paraphrases and inferences of course can have other effects as well as indicating acceptance, such as changing perspective or point of view. Following traditional semantic assumptions, these types of changes are not considered to be additional information [Barwise, 1988].

(13)   (15) H: Oh no. *IRA's were available as long as you are not a participant in an existing pension.*[6]
(16) J: Oh I see.
Well *I did work I do work for a company that has a pension*
(17) H: ahh. **Then you're not eligible for eighty one**.

Given this variety in form, and the real-time nature of conversation, we next ask what distributional features speaker A might use in identifying an utterance by speaker B as an acceptance.

2.2   Distributional Analysis of Acceptances

One cue that speaker A may use is that explicit acceptances are logically consistent with what A has asserted or proposed [Whittaker and Stenton, 1988, Walker and Whittaker, 1990]. As discussed in section 1, logical consistency is necessary for acceptance, although it is not sufficient. In order to determine what other cues speaker A might use to recognize B's utterance as an indicator of acceptance, I first defined a superclass of repetitions, paraphrases and making inferences that I could use in tagging a corpus of dialogues. This superclass is the class of INFORMATIONALLY REDUNDANT UTTERANCES (IRUs) [Walker, 1993a]:

> An utterance u_i is INFORMATIONALLY REDUNDANT in a discourse situation $\mathcal{S}$ if u_i expresses a proposition p_i, and another utterance u_j that entails, presupposes or implicates p_i has already been said in $\mathcal{S}$

It will be useful in what follows to have a term that we can use to refer to the utterance u_j that originally introduced the propositional content of the IRU to the common ground. This is called the IRU's ANTECEDENT.[7]

Once the class of IRUs was defined, I collected 184 instances of IRUs from the financial advice dialogue corpus [Pollack *et al.*, 1982]. In order to determine what cues speaker A might use to recognize B's utterance as an acceptance, I coded each IRU for a number of distributional factors that were hypothesized as potential cues. First, each IRU was coded for the logical relationship of the IRU with its antecedent and for the distance of the IRU from its antecedent. It was hypothesized that these factors might affect the realization of the IRU. In addition, since explicit acceptances provide no new information, a plausible hypothesis was that acceptances would be prosodically marked as old information [Prince, 1981b, Brown, 1983, Terken, 1985, Pierrehumbert and Hirschberg, 1990]. Both phrase final tone and phrasal intonational contour were coded.

The first thing that the corpus analysis makes apparent is that IRUs have other discourse functions besides indicating acceptance. For example, a speaker may elaborate his/her own contribution with an IRU as H does in 14:

(14) But separate it. I don't want it all in one.

An examination of IRUs that indicate acceptance however shows that they are said by speaker B immediately after speaker A finishes speaking. Note that in dialogue 10, the ANTECEDENT of the

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[6]I R A stands for Individual Retirement Account which is a way of putting money aside tax free until some time in the future, such as when the holder retires.

[7]IRUs in fact often have multiple antecedents in the discourse, e.g. the utterance that made an inference explicit in 6. In these cases, the most recent utterance is the IRU's antecedent.

IRU in utterance 36 is utterance 35. In dialogue 11, the antecedent is utterance 26 and the IRU is utterance 27. In 12, the antecedents are utterances 18 and 19, and the IRU is utterance 20. In dialogue 6, the antecedents are utterances 15 and 16, and the IRU is utterance 17.

Thus, if we simply classify IRUs by speaker, and by location with respect to their antecedents, we find that acceptance IRUs can be largely described by two distributional factors:

1. Adjacent: the IRU sequentially follows its antecedent utterance, ie. the IRU is U_{n+1} and its antecedent is U_n.

2. Other: the speaker of the antecedent of the IRU is different than the speaker of the IRU.

This Adjacent plus Other position is what was called the ATTITUDE LOCUS above; IRUs that occur in this position are termed Attitude IRUs. Figure 1 shows that the Adjacent plus Other parameters divide the corpus roughly into two categories, with 93 IRUs classified as Attitude IRUs according to these parameters.

	Repetitions	Paraphrases	Inferences
Attitude IRUs	54	15	24
Not Attitude IRUs	6	43	32

Figure 1: Distribution of all IRUs. Attitude IRUs indicate the Other speaker's attitude toward a speaker's assertion or proposal, and are Adjacent to the assertion or proposal.

Boundary Tone	High	Mid	Low
Attitude IRUs	24	28	15
Not Attitude IRUs	3	22	32

Figure 2: Distribution of Final Tones on Attitude IRUs (Adjacent plus Other) vs Other IRUs

Most, but not all, Attitude IRUs are explicit acceptances. The exceptions are those whose phrase final tone is a high rise (question contour). See figure 2. This subset with a high phrase final tone were called ECHOES by Cruttenden, who states that an echo 'queries the whole or some part of a previous utterance' [Cruttenden, 1986].

The remainder of the IRUs in the attitude locus, which are realized with final mid and low tones, all indicate acceptance. Figure 2 shows that falls to mid are significantly more likely to occur on acceptances than on IRUs that have other functions, ($\chi^2 = 5.695, p < .02, df = 1$). This finding is consistent with the claim that final mids mark non-assertion, non-completion, and hearer-old or predictable information [Ladd, 1980, Liberman, 1975, McLemore, 1991], and means that it is plausible that in about half the cases, A can recognize that B's utterance, in the attitude locus, indicates acceptance simply from the final tone.
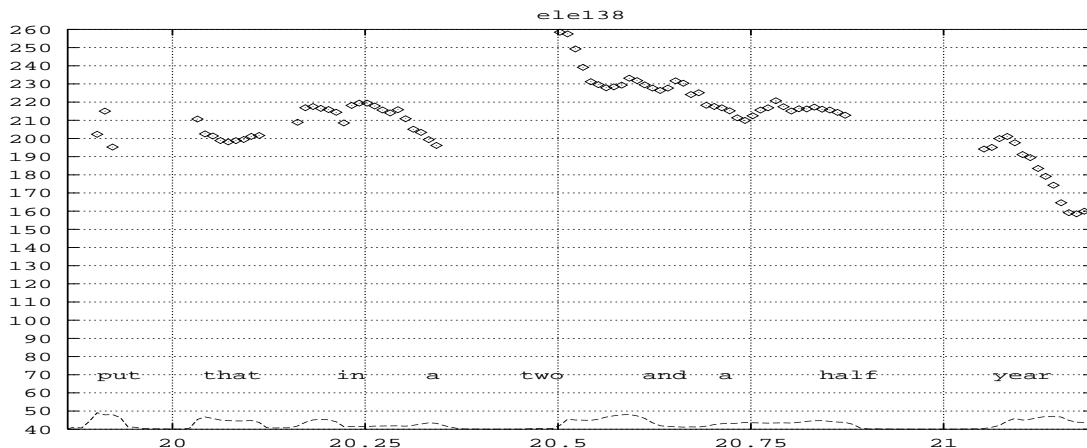
Figure 3: E's indication of acceptance by repetition from utterance 27 in dialogue 11. Y-axis is F0, X-axis is time.
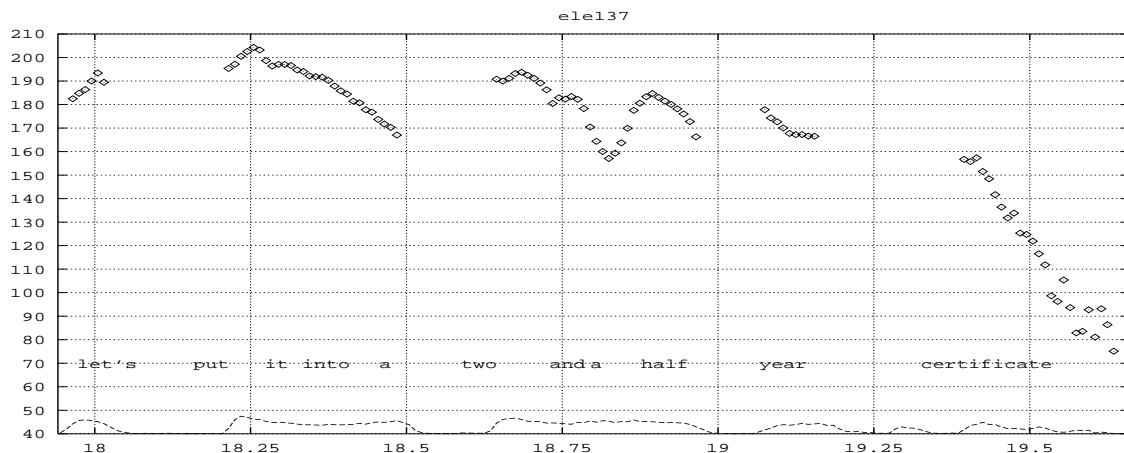

Figure 4: H's original assertion of utterance 26 in dialogue 11. Y-axis is F0, X-axis is time.

Turning to phrasal intonational contour, the distributional analysis shows that, in most cases, acceptances are treated as old information by being realized with either sustained tones or with downstepped H*+L accents [Pierrehumbert, 1980, Pierrehumbert and Hirschberg, 1990]. An example of a sustained tone is given in figure 3, which is the prosodic realization of utterance 27 in dialogue 11. The F0 of this figure should be contrasted with that in figure 4 which shows how the original assertion, utterance 26 in dialogue 11, was prosodically realized. Note that *put it* was accented in Figure 4 but that *put that* is not accented in Figure 3. Note also that the original assertion ends with a final fall to low whereas E's acceptance IRU ends with a final fall to mid.

The repetition in 9 in dialogue 15, which indicates acceptance, illustrates the use of downstepped H*+L accents:

(15)   (8) H: You can stop right there: *take your money*
        (9) J: Take the money.
        (10)H: Absolutely.....

8

As shown in figure 5, the utterance in 15-9 is realized as a series of downstepped highs, with an H*+L pitch accent first on *take* and then on *money*. The final tone is a mid. Contrast figure 5 with the prosodic realization of of *take the money* in H's original assertion in figure 6. In figure 6, the verb *take* receives the primary accent and this accent is a simple H*, and the utterance ends with a phrase final low rather than a mid.

Thus, differences in both phrasal intonational contour and phrase final tone indicate that acceptance IRUs will in general sound qualitatively different than their original assertions. The differences in prosodic realization mean that if original assertions were realized with identical prosody to that of acceptance IRUs, these assertions might be interpreted differently. Furthermore, if acceptance IRUs were realized with the prosody of the original assertions, they would probably not be interpreted as acceptances. One ramification of these differences is that it is plausible that speaker A can identify these utterances as acceptances without doing any logical processing at all; A may simply listen to their prosodic realization.
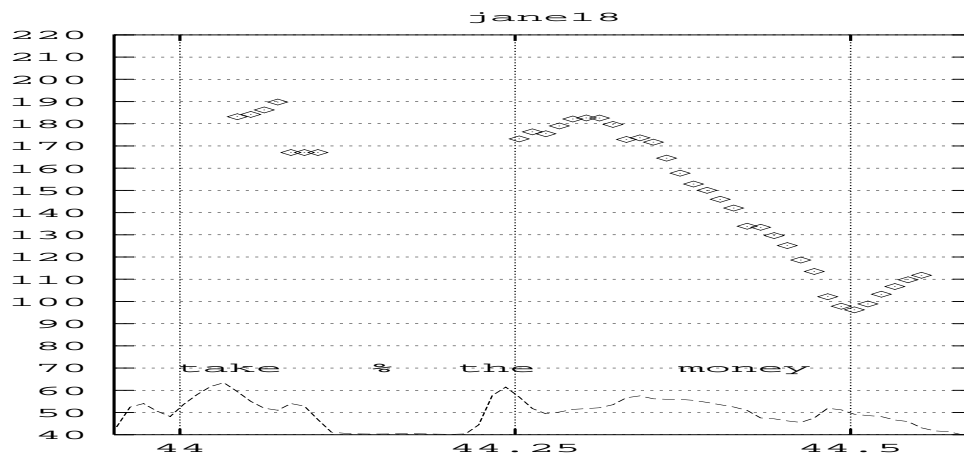

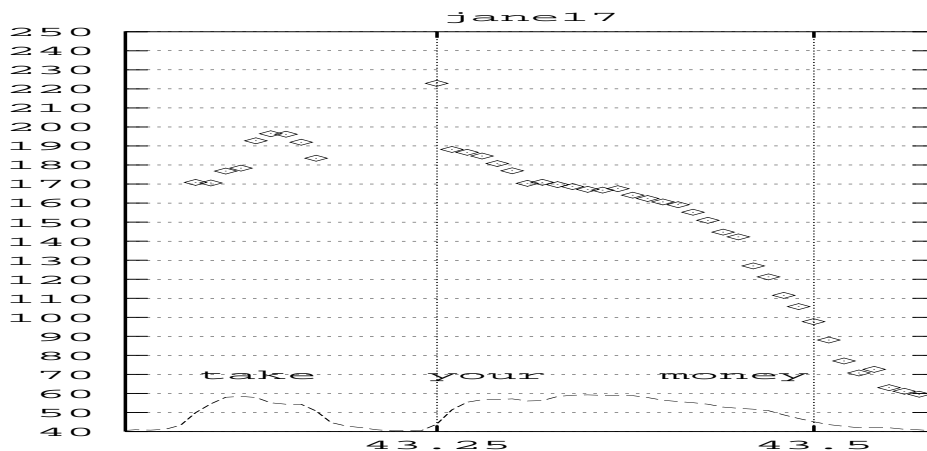Figure 5: J's acceptance IRU in utterance 9 in dialogue 15. Y-axis is F0, X-axis is time.

Figure 6: H's original assertion in utterance 8 in dialogue 15. Y-axis is F0, X-axis is time.

9

Finally, consider figure 2 again, and the 27 IRUs with high boundary tones, called ECHOES by Cruttenden. The existence of these echoes is strong evidence for a conventional assumption of an ATTITUDE LOCUS, as discussed above. If we assume that Attitude IRUs with high boundary tones (final rises) conventionally indicate non-acceptance, then Figure 2 shows that the vast majority of IRUs said with high boundary tones are in the ATTITUDE LOCUS ($\chi^2 = 17.68, p < .001$). Furthermore, the three IRUs in figure 2 with final highs that are **not** in the ATTITUDE LOCUS, are explicitly marked as being out of place, as in the utterance of *Oh hang in there my friend* marking H's paraphrases with phrase final rises in 16:

(16)   M: .... First of all, you know, ah there's an outfit here in Philadelphia that you know, that I put money in at a certain interest, and I can I can borrow on it at one percent more. And *it's a 30 month deal*, so I have not received any interest on it. You know I don't have to show any interest on it *because they have not given me you know any 1099's or anything*, but..
H: Oh hang in there my friend
M: I'm hanging in there.
H: **You have a 30 month certificate?**
M: Right.
H: **And they have not sent you a 1099**?

This supports the claim that A can use the fact that B's acceptance or rejection is expected in the ATTITUDE LOCUS to make default inferences about acceptance. In addition, both the utterance's position in the attitude locus, and the prosodic realization function as primary cues for speaker A that speaker B's utterance indicates acceptance.

2.3   Summary of Acceptance

This section first discussed conventions of dialogue such as the existence of the attitude locus and the collaborative principle, that provide the basis for the dialogue model assumed here. Then, I showed how utterances with 'no new information' in the attitude locus function as indicators of acceptance, and argued that these utterances assert understanding while merely implicating acceptance. next, I used the distributional analysis of acceptances to provide support for the existence of the attitude locus, and to show that sequential organization and prosodic realization are primary cues that speakers in dialogue can use to infer that an utterance implicates acceptance. In section 5, I show how the model of the common ground models the function of these explicit acceptances in asserting understanding and implicating acceptance.

3   Inferring Rejection in Dialogue

In section 1, I introduced Horn's classification of rejection [Horn, 1989]. In this section, I discuss how the naturally occurring examples of rejection that I have collected from the literature and from the financial advice corpus fit into Horn's classification. It will be convenient to divide rejections into two types: rejections of assertions and rejections of proposals. In 55 dialogues, I found only 19 examples of rejecting assertions and 12 examples of rejecting proposals. While few in number, these examples highlight three problems with previous work:

1. The literature mainly discusses the logical inferences required to recognize the rejection of an assertion and doesn't specify the basis for inference of the rejection of proposals (advice, offers etc.)

2. Previous classifications of rejection are incomplete.

3. Types of rejections not previously noted pose a problem for the assumptions and mechanisms of current theories about how to represent the common ground.

First, in section 3.1, I discuss the forms of rejecting assertions, and then in section 3.2, I discuss the forms for rejecting proposals. In each example, the rejection form is indicated in **boldface**, while the assertion or proposal that it rejects is indicated in *italics*.

3.1 Rejecting Assertions

The simplest cases of rejecting assertions are the types of denial and contradiction discussed in previous work. In this small corpus, no examples of implicit denial were found, but both contradictions and denials are represented. Since these are straightforward, I will not discuss them further. The other types of rejecting assertions are categorized into two classes. The first class are those where the inference of rejection is based on the content of the rejection itself, but the inference of rejection follows from an implicature as in example 6. I call these IMPLICATURE REJECTIONS. The second class relies on drawing inferences based on epistemic inference rules; these are dubbed EPISTEMIC REJECTIONS.

3.1.1 Rejection by Implicature

The class of IMPLICATURE REJECTIONS is illustrated by example 6, where B's rejection shows that logical inconsistency is not necessary for rejection. So how does A infer that B's utterance is a rejection? A plausible, and I argue, the correct analysis, is that B's response rejects A's by the process of scalar implicature, similar to the implicature shown in 18, generated by the fact that 17B is 'less informative' than it might have been [Hirschberg, 1985, Gazdar, 1979, Horn, 1972]:

(17) A: Is the new student brilliant and imaginative?

   B: He's imaginative.

(18) He's not brilliant.

In the remainder of this section, I present the relevant aspects of Hirschberg's theory of scalar implicature [Hirschberg, 1985] in order to show how the inference of rejection is derived in 6, and discuss the issues that arise from this analysis.

Hirschberg's theory of Scalar Implicature   Quantity implicatures arise from the use of a less informative item in a sentence, implicating that the same sentence with a more informative item is either false or unknown. Thus the less informative *some* in 19 gives rise to the implicature in 20:

(19) Kim ate some of the cookies.

(20) Kim didn't eat all of the cookies.

Scalar implicatures are a type of quantity implicature [Horn, 1972, Gazdar, 1979]. Hirschberg's theory of scalar implicature specifies the conditions under which a speaker may LICENSE a scalar implicature and that a hearer must have access to in order to INFER that a speaker intended a particular scalar implicature [Hirschberg, 1985]. For the class of IMPLICATURE REJECTIONS, we will see below how Hirschberg's conditions on licensing and inferring implicatures apply directly to the licensing and inferring of rejection implicatures.

Scalar implicatures are calculated from surface semantic representations of propositions, i.e. from logical form, by identifying a potentially scalar subformula in the logical form, identifying the scale or scales that this subformula belongs to, and generating implicatures for alternate and higher values of that scale. The theory depends on:

1. $\mathcal{O}$, a salient ORDERING or scale, defined as any partially ordered set, POSET, relation over a set of scalar expressions $e_1 \ldots e_n$;

2. a means of ranking sentences as HIGHER, LOWER or ALTERNATE sentences with respect to $\mathcal{O}$; and

3. a specification of whether the speaker uttered a sentence which AFFIRMED, DENIED or declared IGNORANCE of a value on $\mathcal{O}$.

A means of ranking sentences is provided by the definition of a scale as a POSET, e.g. a HIGHER sentence is a sentence with a higher value from the POSET. The expressions e_i which can participate in scales are any constant, predicate, logical or epistemic operator, connective or quantifier symbol of a proposition p_i or any wff that is a subformula of p_i. Here we only consider sentences that AFFIRM a value e_i on a scale $\mathcal{O}$ in an asserted proposition p_i, as defined in 21. A sentence p_i is SIMPLE with respect to an occurrence of a component expression e_i iff p_i contains no instances of negation with wider scope than e_i.

(21) AFFIRM(S, e_i, p_i) iff $(p_i = \text{BEL}(S, p_j) \wedge \text{SIMPLE}(p_j, e_i))$

As 22 shows, Hirschberg's formulation assumes that every utterance can be represented as S's commitment to belief in some proposition or to lack of such belief. In other words an utterance which realizes a proposition p_i is represented as BEL(S,p_j) or ¬BEL(S,p_j).

The SCALAR IMPLICATURE INFERENCE RULE (SIIR) for AFFIRMED sentences is in 22,[8] where $\mathcal{O}$ is an ordering, C_h is the context, and BMB is the standard Belief in alternating mutual belief:

(22) SCALAR IMPLICATURE INFERENCE RULE(SIIR):
$\exists \mathcal{O}(BMB(Salient(\mathcal{O}, C_h)$
$\wedge Realize(u_i, Affirm(S, e_i, Bel(S, p_i))$
$\wedge (HigherSent(p_i, p_j, \mathcal{O}) \vee AltSent(p_i, p_j, O)))$
$\rightarrow ScalarImp(S, H, u_i, \neg BEL(S, p_j), C_h)))$

The SIIR says that if there is a scale $\mathcal{O}$ that is salient in the context and a speaker S affirms a sentence p_i with a component expression e_i, and there is another sentence p_j which is a higher sentence or alternate sentence to p_i with respect to scale $\mathcal{O}$, then the speaker may implicate that

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[8]See [Hirschberg, 1985] for inference rules for utterances which express denial and and declaring ignorance.

it's not the case that s/he believes p_j, i.e. either s/he doesn't know whether p_j or she believes not p_j.[9]

Figure 9 illustrates potential sample scales $\mathcal{O}$ [Horn, 1989, Hirschberg, 1985]. Some of these can be defined by entailment such as the conjunctive assertion scale: $P \wedge Q$ entails the truth of P and of Q. Others must be based on common knowledge of the world: (VW, Opel, Honda, Chevy). Still others are based on common knowledge between the speaker and hearer and only constructed for that particular interaction, e.g. (a dog, a stove) as a set of *things we can afford* [Ladd, 1980].

SAMPLE SCALES $\mathcal{O}$

(definite, indefinite)
(all, most, many, some, few)
(necessarily, probably, possibly...)
(.... ten, nine, eight....)
(must, should, may, ...)
(excellent, good)
(hot, warm)
(always, often, sometimes,...)
(succeed in Ving, try to V, want to V)
(love, like, don't mind)
(none, not all)
$(P, P \wedge Q$)
(apples,bananas,pears,plums,oranges)
(VW, Opel, Honda, Chevy)
(a dog, a stove)
(a book, half of a book, a chapter of a book)

Thus if we instantiate the SIIR by letting u_i be the assertion in 19, the scale $\mathcal{O}$ be the scale of quantifiers (*all, most, many, some, few*), the higher sentence p_j be 23, and the context C_h the null context, we get the implicature in 24, glossed in 20.

(23) Kim ate all of the cookies.

(24) ScalarImp(S, H, *Kim ate some of the cookies*,
$\neg$ BEL(S, *Kim ate all of the cookies*), C_h)))

The predicate ScalarImp in 24 is defined so that implicatures can be felicitously CANCELLED, as in 25a, as well as REINFORCED as in 25b.

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[9]The rule is based on a three-valued logic. The denial ($\neg$ T) of one of three logical possibilities (T,F,#) in a three valued logic is equivalent to the disjunction of the other two (F $\vee$ #). Note that $\neg$ Bel(S, p_j) will be true in a two-valued logic just in case BEL(S, $\neg p_j$) and similarly, $\neg$BEL(S,$\neg p_j$) will be true just in case BEL(S,p_j). In other words, where logical systems do not permit the representation of ignorance, scalar implicatures may still be represented as simplified by the assumption of these systems in the same way that ignorance is simplified by them [Hirschberg, 1985], p. 81.

(25) a. Kim ate some of the cookies, and in fact Kim ate all of them.

   b. Kim ate some of the cookies, but Kim didn't eat all of them.

   The tests of CANCELLABILITY and REINFORCEABILITY distinguish conversational implicatures from entailments [Grice, 1975, Hirschberg, 1985]. In 25b, the implicature was cancelled by a subsequent statement, but can also be cancelled by **prior** context, so that the implicature never arises, as in 26.

(26) Kim didn't eat all of the cookies. She ate some of them.

   Thus in every respect, scalar implicatures have the logical properties of normal DEFAULT inferences [Perrault, 1990]. The remainder of the paper assumes that the consequent of the SIIR has the logical status of a default, although unlike defaults, scalar implicatures must be specifically LICENSED by features of the context [Hirschberg, 1985].

Applying Hirschberg's theory to the examples   Consider how this theory explains the other examples we have seen. In 17, A introduces a question as to whether a, *the new student*, is both *brilliant* and *imaginative*. The conjunction evokes the scale of conjunctive assertions $(P, P \wedge Q)$, where P is *The new student is imaginative* and Q is *The new student is brilliant*, and $P \wedge Q$ is a higher sentence than P. Thus because speaker B affirms P with 17B, B implicates the denial of $brilliant(a)$ in 18.

   Now, most discussions of implicatures consider only question contexts such as 17; out of the 185 naturally occurring examples in Hirschberg's thesis, 180 implicature generating responses are responses to a question. But note that the implicature shown in 18 still arises in the context of the assertion in 27A, showing that the implicature in 18 is not dependent on the question context given in 17.

(27) A: The new student is brilliant and imaginative.

   B: He's imaginative.

   Thus, we can use the SIIR to license the inference of rejection in 6 if we take the salient scale $\mathcal{O}$ to be (*a man, something*). Then 6A is a higher sentence than 6B and B's assertion implicates that it isn't the case that B believes 6A.

   Furthermore, these implicatures are understood as rejections as long as a salient scale can be identified. In 28, from [Hirschberg, 1985], the salient scale is (love, like, don't mind). Again note that 28B is logically consistent with 28A since *like* entails *don't mind*.

(28) A: She likes it.

   B: I don't mind it. (Hirschberg's (125))

Issues with Implicature Rejections   If scalar implicatures are generated in the context of an assertion, then two issues arise.

   The first issue is that a less informative U_2 following an assertion U_1 may ACCEPT U_1 rather than REJECT it, as exemplified by example 1. After discussing the remaining types of rejection below, Section 4 discusses how differences in information structure can be used by the hearer as cues for distinguishing acceptance and implicature rejection.

The second issue is cancellability: implicatures only arise when they are consistent with the context as shown by example 26. Yet 18 is not consistent with 27:A, so 27:A cannot have been added to the context as an assertion before the utterance of 27:B. I leave this issue aside until section 5, to be dealt with by the model of the common ground introduced there.

3.1.2 Epistemic Rejections

The types of rejections discussed so far all rely on detecting logical inconsistency or scalar implicatures by inference rules that operate within the domain of the content of what is being discussed. There are an additional three classes of rejecting assertions whose identification relies on detecting conflicts that result from the application of default epistemic inference rules.

Epistemic inference rules are rules of epistemic logic by which an agent can make inferences about other agents' beliefs. While there are many possible systems of epistemic inference, here I draw on a set of default rules used by both Perrault and by Appelt and Konolige in their work on expressing the effects of speech acts as defaults of an epistemic inference system [Perrault, 1990, Appelt and Konolige, 1988]. [10] My assumption is that these default rules of epistemic inference have the same logical status as implicatures, and that the standard problem of conflicting defaults can arise between these inferences and implicature inferences as specified by the SIIR. See also [Joshi *et al.*, 1986]. The first rule is given in 29:

(29) BELIEF TRANSFER RULE:
  Say(A,B,p) $\rightarrow$ Bel (B,p)

The Belief Transfer Rule states that if one agent A makes an assertion that p then by default another agent B will come to believe that p. The second rule is in 30:

(30) BELIEF PERSISTENCE RULE:
  Bel (B,p,t_0) $\rightarrow$ Bel (B,p,t_1)

The Belief Persistence Rule states that if an agent B believes p at time t_0 that by default agent B still believes p at a later time t_1.

These rules provide the basis for inferring three additional types of rejections:

1. Denying Belief Transfer: agent B can deny the consequent of the Belief Transfer Rule by expressing doubt as to the truth of A's assertion or by negatively evaluating A's assertion as to its 'sensibility'

2. Asserting Inconsistent Past Belief: agent B can create a conflicting default with Belief Transfer and Belief Persistence by asserting a past belief which, if it persisted, would be inconsistent with the results of the Belief Transfer Rule.

3. Cite Contradictory Authority: agent B can create conflicting defaults with the Belief Transfer rule by stating another assertion attributed to another agent, whose content contradicts what A has just asserted.

Below I will give examples of each of these types.

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[10] For convenience I have short circuited the inference system so that Belief Transfer is not mediated by a rule by which agent B can infer from a declarative utterance by speaker A that speaker A believes the content of that utterance. With that system the Belief Transfer Rule has speaker A's belief as the antecedent, i.e. speaker A's belief is the reason for speaker B to adopt a belief in the proposition p, rather than speaker A's assertion as we do here.

Denying Belief Transfer Conversant B can deny the consequent of the Belief Transfer Rule by expressing doubt as to the truth of A's assertion as H does in 31 in utterance 14:

(31) (11) B: Well ah *he uh ... he belongs to a money market fund now and uh they will do that for him.*
(12) H: The money market fund will invest it in government securities as part of their individual retirement account – is that what you're saying?
(13) B: Right.
(14) H: **I'm not so sure of that.**

   The hearer can also deny the effects of the Belief Transfer Rule by negatively evaluating A's assertion as to its 'sensibility', as in utterance 12 in 32:

(32) (8) H: How much are you talking about?
(9) E: About 65 thousand dollars.
(10) H: And if you are to take it periodically, what would that give you?
(11) E: *I don't know - nobody seems to be able to give me any kind of an answer.*
(12) H: **That doesn't make sense**.

Inconsistent Past Belief Inferring that B's expression of an inconsistent past belief is a type of rejection relies on detecting conflicting defaults with the Belief Transfer Rule and the Belief Persistence Rule. The simplest case is shown in 33 and 34 where two beliefs directly conflict, but the relevant past belief can be any inconsistent belief q where q $\rightarrow \neg$ p is a mutually believed rule of inference.

(33) Say(A,B,p) $\rightarrow$ Bel (B,p)

(34) Bel (B,$\neg$ p,t_0) $\rightarrow$ Bel (B,$\neg$p,t_1)

   An expression of an inconsistent past belief is shown in dialogue 35 in M's utterance in 13:

(35) (6) H: You have a 30 month certificate?
(7) M: Right .
(8) H: And they have not sent you a 1099?
(9) M: No, ...
.....
(12) H: *Then they are remiss in not sending it to you* because that money is taxable sir.
(13) M: I know it's taxable, **but I thought they would wait until the end of the 30 months.**
(14) H: No sir......

Citing Contradictory Authority Inferring that citing a contradictory authority is a type of rejection relies on recognizing two inconsistent instantiations of the Belief Transfer rule as shown in 36 and 37:

(36) Say(A1,B,p) $\rightarrow$ Bel (B,p)

(37) Say(A2,B,¬p) → Bel (B,¬p)

In other words, conversant A1 asserted p and conversant A2 asserted ¬p, potentially leaving B in an inconsistent belief state caused by the conflicting defaults generated by the alternate instantiations of the Belief Transfer Rule. As in the case of inconsistent past beliefs, any conflicting belief q where q → ¬p is a mutually believed rule of inference can generate a conflicting default of this type.

In the corpus of rejections, citing contradictory authority is used to reject the talk show host's assertion three times, with the local bank, the managers of a money market fund, and the IRS all serving as alternate sources of expertise. An example is found in 38 where, in a continuation of dialogue 31, B asserts in 15 that the managers of the money market fund support his original assertion in 11, thereby indicating that he rejects H's rejection in 14:[11]

(38) (15) B: **That's what they told me.**
(16) H: I'm not so sure of it.
They may move it ah into a into a government securities fund, but I'm not so sure that they can move it into individual securities – check that out .

3.2 Rejecting Proposals

The rejection of proposals is analyzed separately from rejecting assertions for two reasons: (1) rejecting proposals have received less attention in the literature; and (2) inferring proposal rejection assumes inferences based on processes of means-end reasoning and deliberation rather than logical reasoning.

The first observation from the corpus analysis of rejecting proposals is that there is a parallel between rejecting assertions and rejecting proposals in terms of inferences based on content in the domain vs. those based on propositional attitudes. I discuss the content class first, and then discuss the second class, which I call DELIBERATION REJECTIONS.

3.2.1 Refusal, Negative Consequence and Precondition Denial

The first observation about rejecting proposals based on content is that the rejecting assertions types of denial, contradiction and presupposition denial have correlates in the action domain. These are respectively:

1. Refusal (with or without a reason for refusing)

2. Asserting the negative consequence of a course of action proposed

3. Precondition denial

Refusal is similar to denial because it straightforwardly rejects the offer, advice or proposal. An example is given in 39, where in utterance 41, R refuses to accept the suggested course of action that H proposes in 38, and includes the reason for the refusal.

(39) (38) H: *And I'd like 15 thousand in a 2 and a half year certificate*
(39) R: The full 15 in a 2 and a half?
(40) H: That's correct.
(41) R: **Gee. Not at my age.**

---

[11]Notice that H treats B's assertion as a rejection by repeating his statement of doubt in 16, and then elaborating on his contradictory beliefs.

The similarity of negative consequence to contradiction rests on the assumption that means-end reasoning in the action domain is equivalent to logical entailment in the truth-conditional domain. Thus asserting the negative consequence of a course of action is equivalent to asserting a logically inconsistent fact, a contradiction.

In dialogue 40, the talk show host H, and the caller D, are discussing an arrangement whereby D's father-in-law would buy a house for D and his wife. H's advice, as summarized in 26 and 28 is for D to buy the house himself by borrowing the money from his father-in-law. D's utterance in 29 leads to an inference of a negative consequence that would arise from following H's advice, the advised course of action would not result in an investment for D's father-in-law.

(40) (26) H: Well I don't like that kind of ownership.
I don't like it from your father-in-law's point of view
and I don't like it from your point of view.
If your father-in-law chooses and if you decide to do it, *let him lend you the money,*
(27) D: mhm
(28) H: and then you can purchase the place, keep the place up, pay him a fair rate of return on his money, and pay him back
(29) D: **Well he kind of wants it as sort of an investment.**
(30) H: I'd rather see him invest elsewhere.

Precondition denial results from a situation in which advice is given that presupposes that a precondition for doing the advised action or for accepting the advice holds. A rejection of this type is simply a statement that a precondition for the advised action does not hold, or a statement from which it is inferrable that a precondition for the advised action does not hold. In 41, H's statement in 13 is an indirect form of a proposal that J should have an I R A for last year. The rejection in 14 is of the second type: the denial of the precondition must be inferred via the rule of Belief Persistence given in 30 from what is actually stated in 14:

(41) (13) H: *And there's no reason why you shouldn't have an I R A for last year.*
(14) J: **Well but I thought they just started this year.**
(15) H: Oh no. IRA's were available as long as you are not a participant in an existing pension.

H's process of inferring that J's utterance counts as a rejection may be assisted from the prosody with which J realizes his utterance. See figure 7, where the accent on *thought* marks its complement as factual [Cruttenden, 1986].

3.2.2 Deliberation Rejections

Deliberation rejections are a way of rejecting proposals that rely on default inferences about the deliberative processes by which an agent evaluates the potential benefit or utility of pursuing a course of action [Bratman *et al.*, 1988, Doyle, 1992]. Deliberation inferences are the action parallel of epistemic inferences. Where epistemic inferences are concerned with belief and truth, deliberative inferences involve intentions and the desirability, utility or expected payoff of one potential intention when compared with another. Rejections based on deliberation rely on default rules of intention adoption and persistence such as those below:
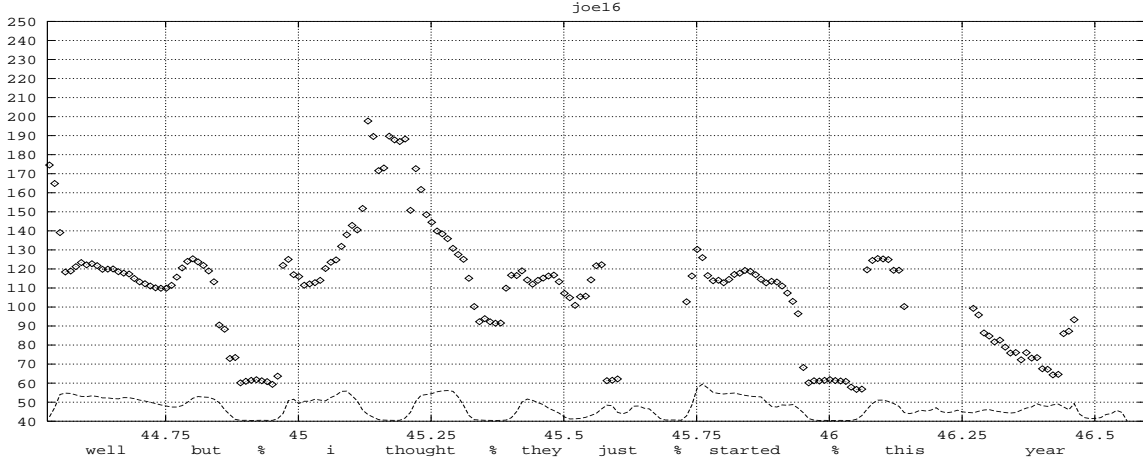
Figure 7: Joe 14. Rejection, Focus Marked. Y-axis is F0, X-axis is time.

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(42) INTENTION ADOPTION RULE:
  $\text{Propose}(A, B, \text{action}_i) \rightarrow \text{Intend}(B, \text{action}_i, \text{degree}_i)$

(43) INTENTION PERSISTENCE RULE:
  $\text{Intend}(B, \text{action}, t_0) \rightarrow \text{Intend}(B, \text{action}, t_1)$

These rules reflect the assumption that conversants in situations such as the financial advice situation commonly have some shared goal of finding a solution to the caller's problem [Grosz and Sidner, 1990, Walker and Whittaker, 1990, Traum, 1994, Chu-Carrol and Carberry, 1994]. Given this shared goal, they then deliberate about which intentions to adopt as means for satisfying that goal [Bratman *et al.*, 1988, Doyle, 1992]. The degree_i in the consequent of 42 is defined by possible courses of action, or alternate potential plans that a conversant may consider, and the degree of the utility of the proposed course of action in comparison with other alternate means. These inference rules are default inference rules (cf. [Joshi *et al.*, 1986, Reiter, 1980, Lascarides *et al.*, 1992]), similar to those for epistemic inference. They support two ways of rejecting proposals:

1. Negative Evaluation: Agent B negatively evaluates the proposed course of action, stating that it is not desirable.

2. Conflicting Intentions: Agent B proposes and possibly evaluates the desirability of another option generated as a means of satisfying the same goal by means-end reasoning

I give examples of each of these types below.

Negative Evaluation Negative Evaluation consists in denying the effect of the Intention Adoption Rule by stating that the degree of expected utility is low. Dialogue 44, utterance 79 is an example of Negative Evaluation, given in response to the proposed course of action in 78:

(44) (78) H: *Put this money aside in treasury notes.*
  (79) M: Now wait, I want..uh **in a 43 tax bracket I didn't think that was too wise,** .....

19

Conflicting Intentions   Conflicting intentions arise when conversant B proposes and possibly evaluates the desirability of another option generated as a means of satisfying the same goal by means-end reasoning.

Dialogue 45 illustrates conflicting intentions inferred by the Intention Persistence Rule. In dialogue 45, H and M are discussing getting some money from a life insurance policy and potentially increasing the level of coverage afterward. Intention persistence is exemplified by M's assertions in 55: M uses the past tense in making her assertion about her potential intentions, and H must infer that those intentions have persisted in order to infer that M is rejecting his proposal to cash the policies in.

(45) (52) H: So what I would suggest is that he apply for insurance to make up that difference. If indeed you feel you need the 12 thousand dollars in insurance. Do you need it?
(53) M: Not really.
(54) H: Well if you don't need it, *then let's cash the policy in*
(55) M: **I wasn't considering cashing the policies, I was considering borrowing the money.**
(56) H: Well let's play it both ways.
(57) M: Ok.

3.3   Rejection Summary

This section discussed the inference of rejection in dialogue. I first distinguished the rejection of assertions from the rejection of proposals. Then I showed that both of these classes of rejections rely on default inference rules. Rejecting assertions introduces defaults of two types: IMPLICATURE REJECTIONS and EPISTEMIC REJECTIONS. I showed how IMPLICATURE REJECTIONS rely on inferences of scalar implicature based on the content of the utterance, while EPISTEMIC REJECTIONS rely on inferences from epistemic inference rules. Then I argued that inferences about rejections of proposals rely on the same distinction between inferences based on the content of the proposal, and inferences based on meta-level rules of inference, deliberation inference rules. I introduced and exemplified new classes of proposal rejection, based on means-end reasoning and deliberation, and showed that these inference rules are default rules of inference whose effects must be accounted for in a model of the common ground.

4   The Role of Information Structure in distinguishing Acceptance and Implicature Rejection

An issue raised in section 3 with the analysis of IMPLICATURE REJECTIONS is that a less informative U_2 following an assertion U_1 may ACCEPT U_1 rather than REJECT it, as exemplified by example 1. The treatment of this issue below relies on detecting regularities in information structure as indicated by prosodic contour. Before presenting the analysis, this section first briefly reviews theoretical background on information structure.

It is well known that information in a discourse does not consist of an unstructured set of propositions, but that speakers form their utterances to **structure** the information they wish to convey. The basis for this INFORMATION STRUCTURE is the speaker's beliefs about what the hearer knows and what is currently salient for the hearer [Prince, 1981b, Prince, 1986, Ward and Hirschberg, 1985, Delin, 1989]. For example, the use of a sentential subject has been shown to correlate with the

speaker's belief that the proposition conveyed is salient shared knowledge, and is what has been called a PRESUPPOSITION [Horn, 1986, Prince, 1981a].

A speaker can indicate information structure through two means: intonational contour or syntactic form. Furthermore, these two means often reinforce one another, so that syntactic constructions which mark information structure are also realized with particular intonational contours [Wilson and Sperber, 1979].

One important type of information structure marking is the marking of variable-containing propositions, which have been called OPEN PROPOSITIONS [Prince, 1981a, Prince, 1986], or P-SKELETONS [Rooth, 1985]. Variables in an open proposition can either be marked by syntactic forms with a gap, such as topicalizations or questions [Prince, 1986], or by intonational contour, in which the location of the variable is marked as FOCAL by prosodic accents of various kinds [Ward and Hirschberg, 1985, Wilson and Sperber, 1979, Jackendoff, 1972].

It is also well known that focus marking can be ambiguous as to the extent of the domain of the variable, but that possible domains can be predicted by using Liberman and Prince's relational theory of stress [Liberman and Prince, 1977, Hirschberg, 1985]. Liberman and Prince's relational theory analyzes stress as binary feature with values of WEAK and STRONG. If lexical items in an utterance have WEAK labels, and are prosodically marked as focal, then the domain of the variable is restricted to that lexical item. This is called narrow focus. If lexical items in an utterance have STRONG labels, and are prosodically marked as focal, then the domain of the variable includes all the nodes of the syntactic tree for the utterance that include that lexical item. The analysis below assumes as theoretical background the use of focus to indicate information structure, and Liberman and Prince's theory for determining the domain of the variable in an open proposition [Liberman and Prince, 1977, Ladd, 1980].

4.1 Distinguishing Acceptance from Rejection

As noted above, an issue with the analysis of IMPLICATURE REJECTIONS is that a less informative U_2 following an assertion U_1 may ACCEPT U_1 rather than REJECT it, as exemplified by example 1. It is plausible that the logical form for 1 includes conjunction as shown in 46:

(46) (house x) ((belong-to Sue x) $\wedge$ (located x Chestnut St.))

Thus, by the same reasoning we used above in the analysis of IMPLICATURE REJECTIONS, we could argue that B's utterance evokes the scale of conjunctive assertions, which in this case includes the conjunction shown in 46, and furthermore that B's utterance realizes a lower item on the scale, namely *on Chestnut St.*, thus implicating that it is not the case that B believes 1A. But B's utterance does **not** implicate that for all B knows it is not **Sue's** house that is on Chestnut St.

Furthermore, none of the naturally occurring types of explicit acceptance mentioned in section 1 generate implicature rejections, even though they are typically logically consistent utterances that realize a subpart of the propositional content of the previous assertion. What is the difference between 1 and 6?

A possible explanation is that A's utterance in 1 has no explicit conjunction, and that explicit conjunction is required to introduce the scale of conjunctive assertions. However, consider the naturally occurring example in 47.

(47) A: We bought these pajamas in New Orleans for me.

   B: We bought these pajamas in New Orleans.

Here, the implicature conveyed by 47B, glossed in 48a, and given in 48b, can be explained most naturally by postulating a conjunctive representation at the propositional level as in 49.

(48) a. But not for you.

b. ScalarImp(B, A, *We bought these pajamas in New Orleans*, $\neg$ BEL(B, *We bought these pajamas in New Orleans for you.*), C_h)))

(49) (pajamas x) ((bought e x) $\wedge$ (located e New Orleans) $\wedge$ (agent e WE) $\wedge$ (benefactor e ME))

Since the implicature in 48B, which indicates rejection, is generated **without** explicit conjunction, this explanation does not seem plausible.

However, previous work on the form of acceptance, discussed in more detail in [Walker, 1993a, Walker, 1993b], provides a partial answer to this problem. In most cases of repetitions that indicate acceptance, the repeated subformula of the propositional representation of U_2 was either (1) previously questioned, i.e. syntactically marked as focal [Prince, 1986], or (2) prosodically marked as focal in U_1. In dialogue 11, the IRU in 27 repeats information marked as focal in utterance 26, as shown in figure 4. The repeated *on Chestnut St.* of 1B would be **focal** information in 1A. Furthermore, as discussed above in relation to explicit acceptances, this repeated focal information is prosodically marked as hearer-old information by the speaker's choice of both prosodic contour and phrase final tones [Prince, 1992].

Thus one key difference between acceptances and implicature rejections is their information structure. Acceptances re-realize focal information from U_1 and mark it as old information. Rejections re-realize the open proposition from U_1, and replace the focal item with a scalarly related item. This suggests that the basis for inference of rejection includes the condition in 50:

(50) SUBSTITUTION OF FOCUS CONDITION:

If an utterance U_2 by a speaker B asserts (proposes) an alternate instantiation of the salient open proposition contributed to the context by an assertion (proposal) U_1 as uttered by a speaker A, and U_2 omits, or provides an alternate or more general instantiation of the focused element e_i of U_1, then U_2 REJECTS U_1.

It follows from the analysis of rejection by implicature that the focused elements e_i are precisely those that potentially license scalar implicatures. Thus, conversants in dialogue can use the SUBSTITUTION OF FOCUS CONDITION as the basis for determining that a scalar implicature has been licensed by a speaker's response,[12] and then infer what has been rejected on the basis of the implicature.

Applying the SUBSTITUTION OF FOCUS CONDITION to the examples thus far, we see that in 47A the focus is *for me*. See Figure 8 as an example of the most natural way to mark focus in this utterance. In 47B, B's replacement of this focus with one that does not include *for me* leads to the construction of the conjunctive scale, which minimally contains ((located e New Orleans) $\wedge$ (benefactor e ME), (located e New Orleans)). The conjunctive scale provides the basis for the rejection implicature.

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[12]This condition appears to define B's utterance as, what Hirschberg calls, a SIMPLE EXPRESSION ALTERNATE, with the addition of the focus constraints. In earlier work, I called this the exclusion of focus condition, because of examples like 47B. However, 47B can be viewed as a substitution of *in New Orleans* for *in New Orleans for me*, and this view is more consistent with the use of the conjunctive scale for generating the rejection implicature.
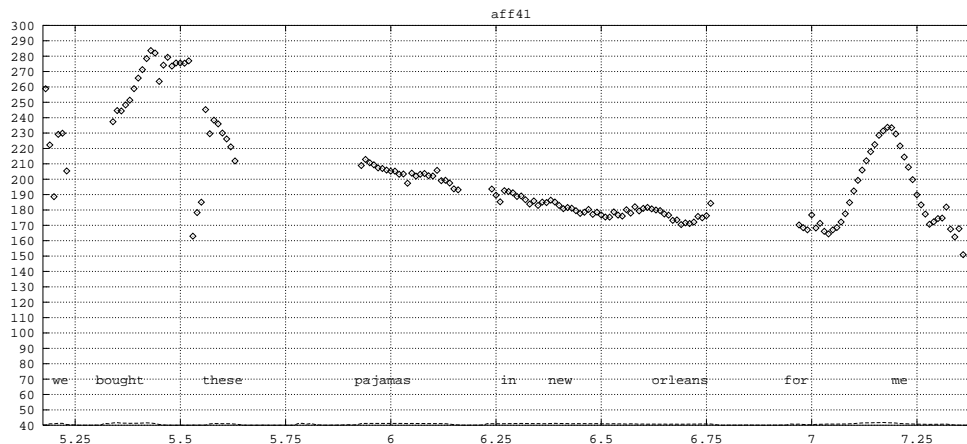
Figure 8: A natural focus marking on the simple declarative in 47A. Y-axis is F0, X-axis is time.

In 6A the focus is *a man* whereas in 6B, the focus is *something*. The scale of *a man, something* is made salient by the focus marking, and *something* is a more general instantiation of *a man*, which then licenses the rejection implicature.

In 17A and 27A the focus is the conjunction of *brilliant and imaginative*, whereas in 17B and 27B, the focus is only *imaginative*. The rejection implicature is licensed by identifying the scale of conjunctive assertions.

In all these cases B's assertion REJECTS A's assertion because it meets the SUBSTITUTION OF FOCUS CONDITION.

In contrast, 1B realizes the focal element e_i of 1A, failing to meet the SUBSTITUTION OF FOCUS CONDITION. Thus 1B accepts 1A, as we might have expected from the fact that it is logically consistent and realizes e_i as hearer-old information [Prince, 1992].
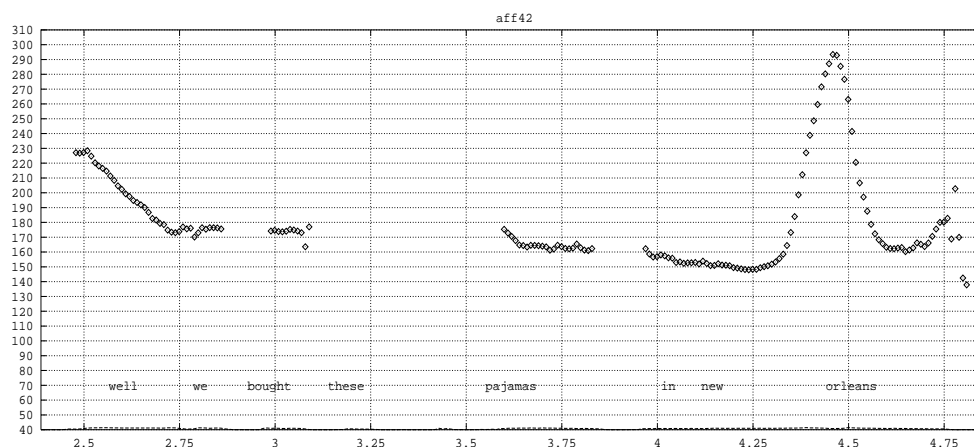

Figure 9: Fall Rise on B's rejection in dialogue 47. Y-axis is F0, X-axis is time.

Furthermore, the SUBSTITUTION OF FOCUS CONDITION provides one explanation of **how** the speaker and hearer coordinate on which scales are salient, and thereby coordinate their mutual beliefs about which scalar implicatures have been licensed [Moser, 1992]. The utterance expressions

23

from which a scale is to be identified are both marked as focal in U_1 and U_2. [13] Thus the focal structure of **both** U_1 and U_2 is critical, for defining the relevant scale $\mathcal{O}$, and for constraining when implicature rejections are felicitous. This can be seen by considering the difference in foci of the naturally occurring 47A and an invented variation given here as 47'A:

(47') A: We bought me these pajamas in New Orleans.

In the original utterance, the marked focus was *for me*. In 47' the focus is most natural on *New Orleans*. B can reject 47A with 47B by substituting an alternate focus, but B's utterance is infelicitous as a rejection of 47'A. This is precisely because the benefactor *for me* is not focal in 47'A. It is not plausible that the propositional representations from which scalar implicatures are calculated are different in 47A and 47'A. Thus the key factor is not simply that the propositional representation makes available a scale of conjunctive assertions, the scale must be identified from the focus/open proposition structure of U_1 and U_2.

4.2   Fall-Rise as an Indicator of Rejection

An additional cue to distinguishing acceptances and implicature rejections may come from the fact that implicature rejections are often realized with a Fall-Rise intonational contour. Fall-Rise is a contour which marks a focus, and which has been claimed to convey an additional meaning as well. Figure 9 shows the use of Fall-Rise, as it would naturally be produced in utterance 47B.[14]

The intonational meaning of Fall-Rise, in addition to marking a focus, has been characterized as incomplete deliberation [Pike, 1945] , uncertainty[Ward and Hirschberg, 1985], focus within a set [Ladd, 1980], a statement or answer with reservation [Halliday, 1967], a reminder that some part of an utterance is background [Gussenhoven, 1984], or a polite softener of denial or rejection, [Horn, 1989, Brown and Levinson, 1987].

In her thesis Hirschberg notes that some of her examples are most felicitous when realized with Fall-Rise as Figure 9 shows for utterance 47B. Hirschberg proposed the use of Fall-Rise as a way of indicating the salient scale in implicature, but stated that there were other ways of indicating scales as well. In discussing example 51, Hirschberg stated that such responses (rejections) are most felicitous with a pitch accent or with Fall-Rise intonation over the indefinite in 51B:

(51) A: Works on the show.

   B: Some show. (Hirschberg's (121) p 96)

Example 51 is one of the 5 examples in Hirschberg's thesis of an implicature generated in the context of an assertion; this suggests that Fall-Rise is more likely to occur as a way to indicate the scale in an implicature rejection than in other implicatures.

Ladd proposed that a Fall-Rise contour on the focused element signals a subset or hyponym relation: the focused element represents a proper subset or member of a contextually accessible set [Ladd, 1980, Horn, 1989]. In addition, he proposes that Fall-Rise signals disagreement or at

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[13]This is similar to, but different than a claim made in [Rubinoff, 1987] that only new information licenses scalar implicatures, since old information may be marked as focal.

[14]Fall-Rise is a type of falling-rising intonational contour describable in Pierrehumbert's system as $L^*+H^-L^-H\%$. It is distinguished from other contours by the fact that it is scooped [Ladd, 1980]. There may be more than one accented syllable in Fall-Rise, and for each such accented syllable there must be an abrupt drop in pitch within the following two syllables. In addition, Fall-Rise is characterized by a sentence-final rise in pitch, as can be seen in figure 9. This description is taken from [Hirschberg, 1985] p. 49, see also [Ward and Hirschberg, 1985].

least amendment [Ladd, 1980], p 155, i.e. 52B disagrees with 52A, by marking *fool* with Fall-Rise, as indicated in 52B. In contrast, the simple fall in 53B signals acceptance by a continuation, i.e. conveys implicit acceptance.

(52) A: Harry's the biggest liar in town.

   B: The biggest $_F$fool$_R$, maybe (.. but I think he means what he says)

(53) A: Harry's the biggest liar in town.

   B: The biggest fool$_F$, maybe. (not only a liar but a fool)

However, Fall-Rise is not **necessary** because an utterance that meets the SUBSTITUTION OF FOCUS CONDITION can reject without Fall-Rise as in 54, even without the explicit amendation marker of *maybe*.

(54) A: Sue's house is on Chestnut St.

   B: Some street$_F$.

Furthermore, the Fall-Rise on 55B, which fails to meet the SUBSTITUTION OF FOCUS CONDITION, is at best interpreted as a bit odd. So Fall-Rise is neither necessary nor sufficient for indicating rejection.

(55) A: Sue's house is on Chestnut St.

   B: It's on $_F$Chestnut$_R$ St.

However, in all likelihood, Fall-Rise plays an important role in helping A disambiguate between rejection and continuation. It seems plausible that 54B could be ambiguous between continuation and rejection without the Fall-Rise or a *maybe*. If Fall-Rise indicates polite softening in this context [Horn, 1989], the presupposition of a less preferred response (cf. [Brown and Levinson, 1987]) would disambiguate between rejection and continuation.

5   Adding to the Common Ground

In sections 2 and 3, I discussed the range of ways that acceptance and rejection are indicated in dialogue. Modeling the function of the various forms introduces several requirements on a theory of how agents A and B remain coordinated on what is in the common ground. These requirements are:

1. modelling the difference between implicit and explicit acceptance

2. explaining how implicatures can be used for indicating rejection

3. explaining how conflicting defaults are resolved in the inference of rejection

In the remainder of this section, I present such a model.

Lewis's Shared Environment model of Common Knowledge   The model proposed here is a computational version of Lewis's Shared Environment model of common knowledge [Lewis, 1969, Clark and Marshall, 1981]. Previous work has noted that the common ground is more accurately described as an individual speaker's 'tacit assumptions' [Prince, 1978] or as 'mutual absence of doubt' [Joshi, 1982, Nadathur and Joshi, 1983]. The MUTUAL SUPPOSITION account of mutual belief presented here models this 'absence of doubt' quality by representing the conversants' assumptions about mutuality as defeasible, depending on the evidence provided by the other conversants in dialogue.

Mutual suppositions can be modeled by an explicit schema proposed by Lewis, called the SHARED ENVIRONMENT model of common knowledge [Lewis, 1969, Clark and Marshall, 1981]. Because conversants don't have access to the mental states of other conversants, mutual supposition must be inferred, based on externalized behavior of various kinds. The inference of mutual supposition can be inferred using the MUTUAL SUPPOSITION INDUCTION SCHEMA, henceforth MSIS:

> **Shared Environment Mutual Supposition Induction Schema (MSIS)**
> It is mutually supposed in a population P that Ψ if and only if some situation $\mathcal{S}$ holds such that:
>
> 1. Everyone in P has reason to believe that $\mathcal{S}$ holds.
> 2. $\mathcal{S}$ indicates to everyone in P that everyone in P has reason to believe that $\mathcal{S}$ holds.
> 3. $\mathcal{S}$ indicates to everyone in P that Ψ.

In this work, the situation $\mathcal{S}$ of the MSIS is the discourse situation, and the population P are the conversational participants. If each of the three conditions given in the MSIS is satisfied then the conversants are justified in inferring that a fact Ψ is mutually supposed. Condition (1) specifies that a public utterance event must be accessible to all of the discourse participants. Conditions (2) and (3) state that what is mutually supposed is derivable from the fact that all participants have access to this public event. In other words, what is believed to be in the common ground is the set of mutual suppositions **indicated** by the occurrence of a sequence of utterance events in a discourse situation $\mathcal{S}$.

Thus, according to the SHARED ENVIRONMENT model an utterance event U in a discourse situation $\mathcal{S}$ licenses the inference of certain mutual suppositions, depending on what U INDICATES in $\mathcal{S}$. However what a discourse situation INDICATES can vary according to assumptions about language conventions and reasoning processes.

Making Lewis's Model Computational   To formalize the INDICATES relation, it is useful to augment the representation of utterance events with two additional constructs: ASSUMPTIONS and ENDORSEMENTS.

Assumptions are beliefs that support a MUTUAL SUPPOSITION. Let Δ be a function on utterances that represents the set of DEFEASIBLE ASSUMPTIONS associated with each utterance event. In previous work, drawing from proposals made by [Clark and Schaefer, 1989, Whittaker and Stenton, 1988], and from Galliers' theory of belief revision [Galliers, 1990, Galliers, 1991], I suggested that one function of the various forms of acceptance is to strengthen the evidence underlying the assumptions Δ associated with an utterance U [Walker, 1992]. Δ consists of assumptions that speaker A makes that reflect A's expectations about the effects of producing an utterance U:

1. ATTENTION : the addressee B attends to U;

2. COMPLETE HEARING: the addressee hears U correctly;

3. REALIZE: the addressee believes that U, said in discourse situation $\mathcal{S}$, realizes a proposition Φ, and that the speaker intended to convey Φ .[15]

4. LICENSE: the addressee believes that U, said in discourse situation $\mathcal{S}$, realizes a proposition Φ and that the speaker intended the addressee to infer Ψ, which follows from Φ as an entailment or by non-logical inference.

5. ACCEPT: the addressee B believes that U realizes a proposal or an assertion, and B accepts the proposal or assertion, i.e. B intends the action proposed or believes what has been asserted.

In other words, in producing an utterance, a speaker assumes that the hearer is attending, and that the hearer will understand the utterance, draw the intended inferences, and accept what is asserted or proposed. These assumptions of the speaker are very weak in terms of mutual beliefs, but can be reinforced by the hearer's response, as we will see below.

The REALIZE and LICENSE assumptions reflect the speaker's assumption about the interpretation process of conversants as they attempt to determine what the utterance U indicates in a discourse. For convenience, two functions are associated with these assumptions. The function $\mathcal{R}$: $(\mathcal{S}, U) \rightarrow \mathcal{P}$, returns the proposition that the speaker of an utterance U in discourse situation $\mathcal{S}$ intends to realize, and which the addressee must identify. The realize function $\mathcal{R}$ is used for both assertions and proposals. The function $\mathcal{L}$: $(\mathcal{S}, U) \rightarrow \mathcal{P}$, returns the proposition licensed as an inference by an utterance U in a discourse situation $\mathcal{S}$, which again the addressee must identify.

We can now represent the inference of acceptance which leads to mutual suppositions of beliefs and intentions as a default inference rule that depends on the assumptions above. The INDICATES function be represented as $\leadsto_\Delta$ where Δ gives the set of associated assumptions, in the Acceptance Inference Rule below, henceforth AIR. Let A and B represent arbitrary members of a population of conversants P, i an arbitrary element of sequential indices I, σ an arbitrary member of the set of sentences Σ.

ACCEPTANCE INFERENCE RULE (AIR)
An utterance event U = (A, B, i, σ) $\leadsto_\Delta$ MS(P, accept(B, $\mathcal{R}(\mathcal{S}$, U)))

Each assumption in Δ has an associated endorsement, which specifies the strength of evidence supporting the assumption. The model distinguishes between three levels of endorsements: HYPOTHESIS, DEFAULT and LINGUISTIC, where HYPOTHESIS is a weaker endorsement than DEFAULT, which is weaker than LINGUISTIC, as represented in 56:[16]

(56) **Ranking on endorsement types**:
HYPOTHESIS < DEFAULT < LINGUISTIC

These three levels are used to represent the difference between expectations and inferred beliefs for which there is little evidence available in the shared environment (HYPOTHESIS), inferred mutual

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[15] Of course the addressee may believe that U in $\mathcal{S}$ realizes some other proposition besides the one that the speaker intended to convey. The realization assumption represents the fact that Φ is not conveyed directly [Reddy, 1979, Schegloff, 1990, Brennan, 1990].

[16] In earlier work, I used five levels of endorsement and Galliers' theory of belief revision uses many more endorsement types. However for modelling mutual belief, as opposed to single agent belief, most important distinctions can be made with only three levels. These three levels could be implemented as levels of the hierarchy in HAEL [Appelt and Konolige, 1988].

beliefs which are inferred as a result of default inference rules (DEFAULT), and mutual beliefs for which explicit linguistic evidence has been provided (LINGUISTIC).

The initial endorsements for each assumption above are shown below:

$\Delta(U)$	ENDORSEMENT
attend (B, U)	hypothesis
hear (B, U)	hypothesis
realize(B, U, $\mathcal{R}(\mathcal{S}$, U))	hypothesis
license(B, U, $\mathcal{L}(\mathcal{S}$, U))	hypothesis
accept (B, U, $\mathcal{R}(\mathcal{S}$, U))	hypothesis

In other words, after speaker A says an utterance, the understanding and acceptance assumptions are licensed as hypotheses only. The basis for this initial endorsement is that speaker A would not make the utterance unless s/he expected the utterance could have an effect on B's mental state, but this expectation is only a hypothesis since B has as yet provided no evidence of mutuality.

In order to make use of these mechanisms, we must specify how the endorsements on assumptions are combined to affect the endorsement on the consequent of an inference rule such as the AIR. In other words, if a discourse situation indicates P and R and P $\wedge$ R $\rightarrow$ Q, what is the endorsement on Q? This must depend on the endorsements on P, R, and P$\wedge$ R $\rightarrow$ Q. The combination rule is based on the intuitive notion that a chain of reasoning is only as strong as its weakest link:

> WEAKEST LINK RULE: The endorsement of a belief P depending on a set of underlying assumptions $a_i, ... a_n$ is MIN(endorsement $(a_i, ... a_n)$)

The WEAKEST LINK RULE means that for all inference rules that depend on multiple assumptions, the endorsement of an inferred belief is the weakest of the supporting beliefs. Thus in the case of the Acceptance Inference Rule (AIR), the inference of acceptance is only endorsed as a HYPOTHESIS after A's assertion. This is a key aspect of the model that allows it to model the types of rejection discussed above, as will be discussed in more detail below.

Speaker B's response can increase the evidence supporting these assumptions, making them less defeasible by increasing the level of endorsement. For example, consider the repetition in dialogue 11, repeated here for convenience:

11 (26) H: That's right. as they come due, give me a call, about a week in advance. But the first one that's due the 25th, *let's put that into a 2 and a half year certificate*
   (27) E: **Put that in a 2 and a half year**. Would ...
   (28) H: Sure. We should get over 15 percent on that.

According to the model the effect of the repetition is as follows:

$\Delta(U_{26})$	ENDORSEMENT
attend(E, U_{26})	linguistic
hear(E, U_{26})	linguistic
realize(E, U_{26}, $\mathcal{R}(\mathcal{S}$, U_{26}))	default
accept(E, U_{26}, $\mathcal{R}(\mathcal{S}$, U_{26}))	default

Assumptions are upgraded from an endorsement type of hypothesis to an endorsement type of default, at a minimum, after speaker B has an opportunity to respond.If B responds with an explicit acceptance, with no new information such as a prompt, repetition or paraphrase, B asserts understanding by providing evidence that upgrades some of the assumptions Δ, that speaker A made in producing the utterance, from their initial endorsement type of hypothesis to an endorsement type of linguistic. The less explicit forms upgrade fewer assumptions, and these end up with an endorsement of default. Figure 10 shows how the combination of endorsement types predicts that the different types of acceptance IRUs have slightly different effects on the common ground.

However, note that after B's response with any of the forms under discussion, the acceptance assumption is only endorsed as a default. This implements the distinction between asserting understanding and implicating acceptance discussed in section 2 [Walker, 1992]. Thus, this analysis accounts for the effect of various forms of acceptance and for the effect of the COLLABORATIVE PRINCIPLE.

NEXT Utterance Type	ASSUMPTION ADDRESSED	ENDORSEMENT TYPE
PROMPT	attention	linguistic
REPETITION	attention, hearing	linguistic
PARAPHRASE	attention, hearing, realize	linguistic
INFERENCE	attention, hearing, realize, license	linguistic
ANY Next Utterance	attention, hearing, realize, license, accept	default

Figure 10: How different types of acceptance responses U_{i+1}, upgrade the endorsements on the Δ assumptions associated with U_i.

In addition, the default endorsement type directly implements inferences whose consequences have the logical status of defaults, such as the scalar implicature inference rule (SIIR), the Belief Persistence Rule and the Intention Persistence Rule. In other words, in addition to the AIR, the other inference rules produce consequents that are endorsed as defaults. [17]

Moreover, the proposed model can straightforwardly account for the various forms of rejection, and explain how the inference of rejection goes through. The key modification is the replacement of the inference rules of previous accounts [Perrault, 1990], with the weaker Acceptance Inference Rule (AIR) which endorses consequents as hypotheses rather than defaults, until after B's response. The AIR replaces both the Belief Transfer and Intention Adoption Rules of previous

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[17]The proposed analysis can be related to default inference rules such as Perrault's by specifying several different Belief Transfer Rules, which have different conditions on the antecedents, and whose conclusions are annotated for level of belief. For example, the initial level of support for acceptance as a hypothesis can be represented by a rule such as 57 which can be defeated by rules whose conclusions are endorsed as DEFAULTS.

(57) HYPOTHESIS BELIEF TRANSFER RULE:
    Say(A,B,p,t) $\rightarrow$ Bel (B,p,t).HYPOTHESIS

accounts [Appelt and Konolige, 1988, Perrault, 1990]. The consequents of these two rules can then be defeated by any of the implicature or default inference rules that can indicate rejection.

For example, consider the case of implicature rejections, as exemplified by 47. Figure 11 shows how the context is updated correctly as a result of a combination of inference rules for (1) Grice's QUALITY MAXIM, that a speaker believes what s/he says, (2) the Scalar Implicature Inference Rule (SIIR), (3) the Mutual Supposition Induction Schema (MSIS), and (4) the Acceptance Inference Rule (AIR).

Utterance	Mutual Suppositions OF P	Endorsement	Rule
A: We bought these pajamas in New Orleans for me.	$\text{Bel}(A, \mathcal{R}(\mathcal{S}, U_1))$ $\mathcal{R}(\mathcal{S}, U_1)$	linguistic hypoth	Quality AIR
B: We bought these pajamas in $_{FR}$New Orleans	$\text{Bel}(B, \mathcal{R}(\mathcal{S}, U_2))$ $\neg\text{Bel}(B, \mathcal{R}(\mathcal{S}, U_1))$ $\neg\mathcal{R}(\mathcal{S}, U_1)$ $\mathcal{R}(\mathcal{S}, U_2)$	linguistic default default hypoth	Quality SIIR, $(P, P \wedge Q)$ MSIS and previous AIR

Figure 11: Effect of Rejection Implicatures

As figure 11 shows, A's assertion provides linguistic evidence of A's belief in the content of the assertion by the Quality Maxim. The content is added to the common ground as a hypothesis only, on the basis of the AIR. B's response first adds that B believes the content of B's assertion to the common ground with an endorsement of linguistic by the Quality Maxim. Then the SIIR with the scale $\mathcal{O}$ of conjunctive assertions leads to the inference of the implicature rejection. The consequent of the SIIR is a default, so the implicature is added to the common ground as a default. On the basis of this addition, the content of the implicature is then added to the common ground as a default using the MSIS. As figure 11 shows, the result is that the consequent of the SIIR, which is endorsed as a default, defeats the speaker's original belief about acceptance, which is only endorsed as a hypothesis. Finally, the fact that B's utterance is a partial acceptance is reflected by the fact that the proposition that B's utterance realizes is added to the common ground as a hypothesis, by means of the AIR.[18]

The same mechanism accounts for epistemic rejections such as asserting an inconsistent past belief. The Belief Persistence Rule is a default rule with no underlying assumptions. Thus the assertion of an inconsistent past belief leads to the addition of an inconsistent current belief endorsed as a DEFAULT. Since the consequent of the AIR is only endorsed as a hypothesis until after B has taken a turn, the default of the inconsistent past belief defeats the inference of acceptance, in the same way that the SIIR default defeats the inference of acceptance in the example in figure 11.

Finally, the treatment is identical for rules for inferring the adoption of intentions. The Intention Persistence Rule is a default rule with no underlying assumptions. The Intention Adoption Rule is subsumed under the AIR simply by positing a different process behind B's decision to accept (deliberation for intentions rather than belief revision for beliefs). So if speaker A makes a proposal, the inference of intention adoption is only endorsed as a hypothesis until after B's turn. Thus the conflicting defaults mentioned in the discussion of example 45 are resolved in the same manner:

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[18]Section 6 discusses whether the content of B's utterance should be stronger than a hypothesis.

the consequent of the Intention Persistence Rule is a default belief, and this default defeats the consequent of the AIR which has replaced the Intention Adoption Rule.

6   Discussion of Open Issues and Future Work

Above we claimed that the partial acceptance nature of implicature rejections is modelled by the model of the common ground in which B's utterance is added to the common ground as a hypothesis. This hypothesis will be upgraded to a default after A's next turn, if A does not reject B's utterance. Since A has previously asserted the content of B's utterance, we can assume this upgrade would occur. An open issue is whether this is adequate for representing the nature of partial acceptance.

There are two possible ways to address this issue. The first way requires a revision of Hirschberg's theory so that the SIIR would only add to the context the implicature, rather than the negation of all of A's utterance. In other words, in figure 11, the implicature listed as $\neg$Bel(B,$\mathcal{R}(\mathcal{S},$ U$_1$)) would be replaced by an implicature for only a subproposition of $\mathcal{R}(\mathcal{S},$ U$_1$), informally $\neg$Bel(B, "for you"). This would also require that the SIIR was sensitive to the type of scale $\mathcal{O}$, in particular it would have to treat the conjunctive scale as different from other scales. The ramifications of these modifications to Hirschberg's theory are beyond the scope of this paper.

A second way of addressing this issue would be that the update rules for the common ground would be more intelligent and note that A had already committed himself to an assertion that entails what B asserted. On the basis of these facts, B's assertion would have a stronger endorsement than hypothesis to start. Again, the ramifications of these modifications are beyond the scope of this paper.

Another type of issue has to do with the potential additional functions of the various forms of acceptance. The analysis here would suggest that the **function** of these forms is to increase the endorsements on assumptions in the common ground. However, although these forms **can** be used to address the set of underlying assumptions, it is not at all clear that this is **why** a conversant chooses one form over another. For example, repetitions are often used in the financial advice talk show, but the broadcast is very clear, and there are no examples where the caller misheard the talk show host. There seems to be no reason why the callers would feel it is necessary to provide evidence of verbatim hearing.

In addition, repetitions and paraphrases are usable as a prompt to the other speaker to say more about a topic. These utterances seem systematically ambiguous between backchannels and prompts. For example, in dialogue 11, E after producing the repetition in 27, attempts to continue her turn by asking for more information. H interrupts her as though she had been prompting him for more support for his advice.

The final issue has to do with generalizations of the account presented here. Implicatures can be used in indicating acceptance, and in other types of rejection. Consider 58 (Hirschberg's (106) p. 90):

(58) A: A very large and vicious dog is about to attack me.

   B: He's large.

B's utterance was less informative than it might have been, leading to the implicature in 59:

(59) He's not vicious.

It would also have been possible for B to respond as in 60B:

(60) A: A very large and vicious dog is about to attack me.

    B: He's not large.

Rather than generating an implicature rejection, B's utterance is an explicit rejection, which however implicates partial acceptance. According to Hirschberg's theory, the denial in 60B leads to the implicature in 61, by which the speaker implicates acceptance of the part of A's utterance that was not rejected.

(61) A vicious dog is about to attack you.

This shows that basing the account here on Hirschberg's theory makes it very general, once we have a mechanism for adding to the common ground that lets implicatures be licensed in the context of an assertion. While there were no naturally occurring examples of rejecting proposals by implicature, the conditions on rejection by implicature will also cover proposals. For example, it is possible to reject a proposal with an ALTERNATE scalar item as in 62B:

(62) A: Let's buy some bananas.

    B: Let's buy some oranges.

It is also possible to reject an assertion with a HIGHER scalar item as in 63B [Horn, 1989]:.[19]

(64) A: Vinnie likes Chuck.

    B: She loves him.

The existence of these generalizations highlights a final limitation of the current study: the corpus on which this analysis was based is small, and the classification of utterances into acceptances and rejections was based on the author's interpretations. Filling in the analysis here and generalizing it must be based on a larger corpus for which speech is available, so that we can determine whether the classification proposed can be reliably applied in a larger corpus.

7   Conclusion

This paper discussed the processes by which conversants in a dialogue can infer whether their assertions and proposals have been rejected by their conversational partners, and specified cues that can be used in this process. This discussion expanded on previous work by showing that logical consistency is a necessary indicator of acceptance, but that it is not sufficient, and that logical inconsistency is sufficient as an indicator of rejection, but it is not necessary.

Section 2 discussed all the various forms of logically consistent acceptances, such as repetitions, paraphrases and utterances that make inferences explicit. I showed by a distributional analysis that the prosodic realization of these utterances marks them as old and predictable information and suggested that hearers can use these prosodic markers as cues for interpretation.

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[19]This is a variation on the metalinguistic negation in 62, in which the speaker is apparently inconsistent:

(63) 'Still', Edwin concludes, 'I did rather like him, didn't you?'
'No', Vinnie says... 'I didn't "rather like Chuck", if you want to know. I loved him'. (Horn's 75', p 401, from Lurie's *Foreign Affairs*, p. 420)

In section 3, I analyze the different types of rejection found in a small corpus from the financial advice domain. I build on Horn's analysis which suggests that the types of rejection include: (a) DENIAL; (b) LOGICAL CONTRADICTION; (c) IMPLICIT DENIAL, where B denies a presupposition of A's; and (d) REFUSAL, also called REJECTION where B refuses an offer or proposal of A's [Horn, 1989]. The corpus analysis highlights the existence of three new classes of rejection: IMPLICATURE REJECTIONS, EPISTEMIC REJECTIONS and DELIBERATION REJECTIONS. I show how these rejections are inferred as a result of default inferences, which, by other analyses, would have been blocked by the context.

In section 4, I discuss how conversants can use information structure and prosody as well as logical reasoning in distinguishing between acceptances and logically consistent rejections. Acceptances re-realize focal information from U_1 and mark it as old information. Rejections re-realize the open proposition from U_1, and replace the focal item with a scalarly related item. I proposed that the SUBSTITUTION OF FOCUS condition can be used in dialogue to determine when IMPLICATURE REJECTIONS are licensed, and discuss the use of Fall-Rise intonation as an additional cue for rejection [Ladd, 1980, Horn, 1989, Hirschberg, 1985].

Finally, I argue that these observations show that we need a model of the common ground that models the difference between implicit and explicit acceptance, explains how implicatures can be used for indicating rejection, and explains how conflicting defaults are resolved in the inference of rejection. In section 5, I propose a model of the common ground that allows these default inferences to go through, and show how this model, which was proposed to account for the wide variety of indications of acceptance, also models the new types of rejection.

8   Acknowledgements

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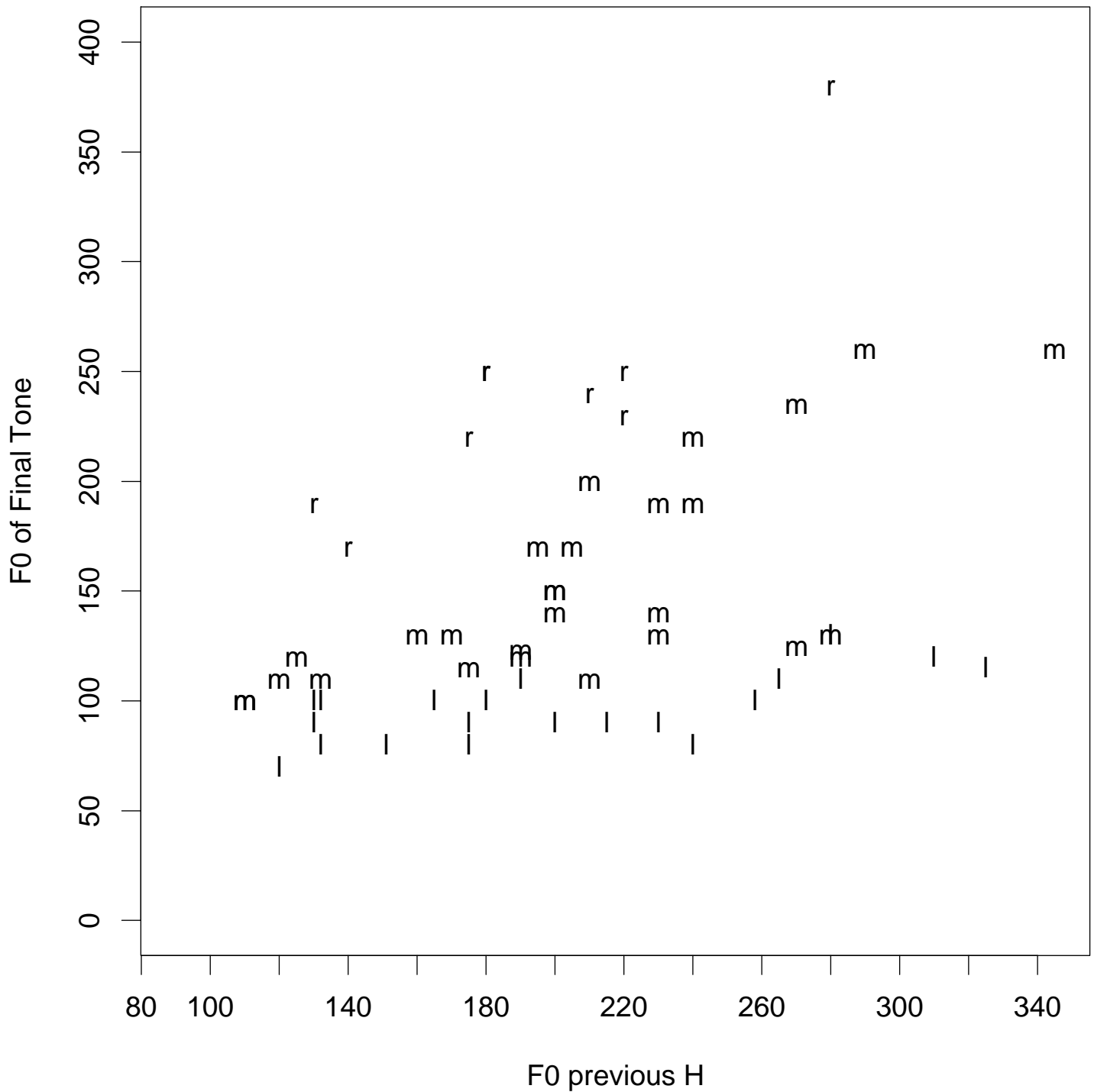
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ATTITUDE: F0 of Boundary Tone by F0 of Previous H

ATTITUDE: Observation numbers